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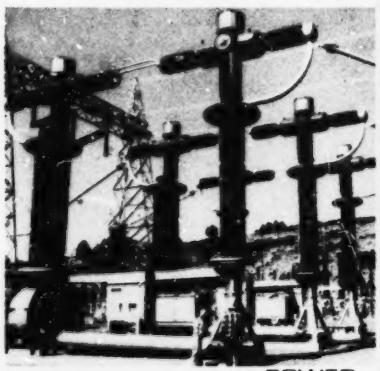
# CENTRAL VALLEY PROJECT

## Its Historical Background & Economic Impacts

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION



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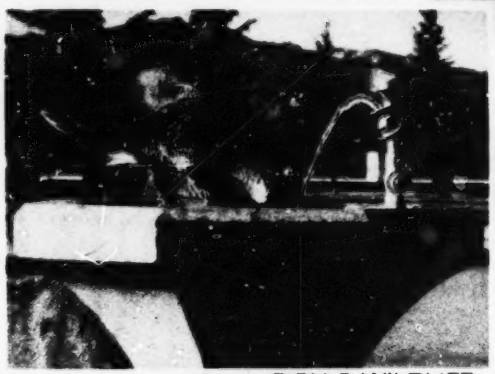

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# CENTRAL VALLEY PROJECT

## Its Historical Background & Economic Impacts

This report was prepared under contract by L.B. Christiansen, formerly a senior official, Bureau of Reclamation, with principal assistance by R.W. Gaines (Retired) and with supportive services from other office staff of the Mid-Pacific Region, Bureau of Reclamation.

July 1981

U.S. Department of the Interior•Bureau of Reclamation
Mid-Pacific Region•Sacramento, California

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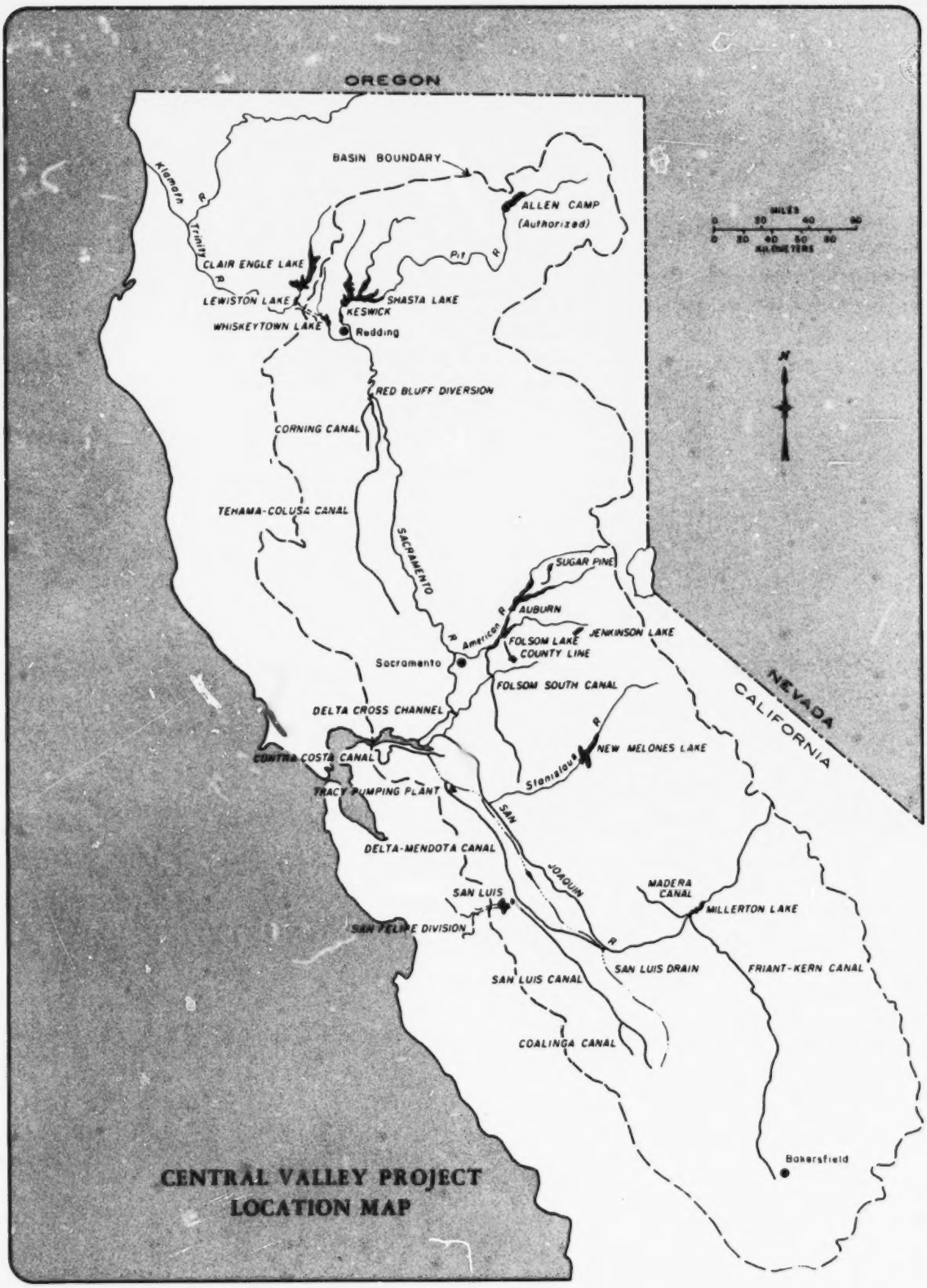


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# foreword

This report has been prepared in response to numerous inquiries and requests for information on the Central Valley Project and its accomplishments. Many aspects of the Project's background are well known and understood by some, but there are many others who lack an adequate appreciation of the Project's accomplishments. This report is intended to provide a capsulized summary of the Central Valley Project's historical background, operations, accomplishments, and economic impacts to serve the general public need for such information.

The evolution of Central Valley Project, through the intensive planning, construction, and operational phases, has certainly faced many difficulties. It is the outgrowth of vast scientific knowledge, technical expertise, and resolution of many difficult legal, policy, and institutional constraints which were overcome. The Project's development has, in many respects, been a function of technological progress. In times past, people could only dream of large water-resource developments which could change the "waterface" of the Central Valley. However, more recently, science and technology have advanced to the stage where large-scale storage, conveyance, pumping, and other interrelated facilities could be realized.

The fact that the Central Valley Project was able to survive and eventually emerge as a highly successful water-resource development system is a great tribute to the many involved. Through perseverance and dedication they were able to compromise the many policy differences and arbitrate the legal and institutional problems encountered. The Project's physical accomplishments and the resultant widespread benefits are a living testimonial to the vision of all who contributed to the culmination of this superb water-resource development.

The two principals primarily responsible for preparation of this report have a combined experience of approximately 70 years in water resource development in general, and with the Central Valley Project in particular. Their close personal association with the Project during many years of its planning and construction provided an intimate knowledge and understanding of the Central Valley Project, its background, and accomplishments, which were of inestimable value in preparation of the report.

A March 1981 special report of the U.S. Bureau of Reclamation (Bureau), titled "Central Valley Project, California, Water Development," provides a detailed accounting of the Project's history and authorizing legislation, as well as an explanation of the interrelationships of the various project components. That report, prepared by Raymond W. Gaines, an employee of the Bureau's Sacramento Regional Office for nearly 30 years until his retirement in 1979, provides an in-depth treatise, which many may find to be an enlightening supplement to this report.



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# Chapter 1
## historical background

### SETTING

The primary impetus for the Central Valley Project may be attributed to the unequal distribution of precipitation and agricultural lands within the Central Valley Basin. Early-day recognition of Nature's imbalance led to numerous studies, of varying degrees of intensity, by local, State and Federal agencies during the late 1800's and in the early part of this century. The basic concept and many of the initial features of the Central Valley Project were incorporated into the 1930 California State Water Plan. This planning background evolved into State-sponsored Federal authorization in 1935. Subsequent additions have expanded the Project scope into a highly integrated basinwide water resource development designed and operated to optimize accomplishments in the broad public interest.

The policy and legal conflicts encountered along the way had to be overcome before subsequent links in the chain could be forged. It was difficult to obtain acceptance of the Project by many public officials and the "engineering fraternity" because of the size and complexity of such an extensive, innovative water-development system. Controversies emerged as to who should benefit from the "cheap power" to be produced and how the "interest-free" irrigation water supplies from the Project were to be apportioned. Still other issues involved reconciliation of various local, State, and Federal statues. Of particular importance in this regard were "acreage limitation," "preference power customer," and "reimbursement" provisions of Reclamation Law, along with the attendant contractual arrangements required.

The Central Valley Basin of California extends for about 500 miles in a northwest to southeast direction; its width averages about 120 miles. The basin is almost completely enclosed by high mountain ranges; it has only a single outlet to the west through San Francisco Bay to the Pacific Ocean. The central portion of this basin --the renowned Central Valley of California-- comprises a large plain which is about 400 miles in length and averages nearly 50 miles in width.

The Central Valley Basin is characterized by three distinct drainage areas: the northern portion, the Sacramento Valley, is drained by the Sacramento River system. The southern portion, the San Joaquin Valley is drained by

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the San Joaquin River and Tulare Basin tributary systems. Waters from the Sacramento and San Joaquin Rivers converge and are commingled in a delta complex before emerging through Carquinez Strait into San Francisco Bay.

The valley floor portion of the basin has two rather distinct seasons. The climate is characterized as Mediterranean, with long, warm, and dry summers, providing ideal growing conditions for an extremely wide variety of quality crops under irrigation. The winters are cool and moist; severely cold weather does not occur, but temperatures drop below freezing occasionally in virtually all parts of the valley.

Floods and droughts, often hazardous and devastating in earlier times, have been minimized in recent years by storage reservoirs and other water control facilities. These facilities have been constructed or developed to limit the ravages of Nature and control available water resources for beneficial uses.

Rainfall on the valley floor is light, and snow almost never occurs. Precipitation decreases dramatically from north to south, with the Red Bluff area near the northern extremity receiving an annual average of about 23 inches, and Bakersfield at the southern end receiving only about 6 inches. Precipitation levels are much greater in the mountain ranges surrounding the valley floor. About 80 inches of precipitation mostly in the form of snow, occurs annually at the higher elevations adjacent to the northern part of the valley, but only about 35 inches falls in the southern mountains. Runoff from these areas is the principal source of supply for water service on the valley floor. About 85 percent of the precipitation occurs from November through April.

## HISTORY

California's history is replete with early-day recognition of the need to control, develop, and relocate available water supplies. The State's first legislature established the office of the Surveyor General in 1850. Provisions of the legislation establishing that office required it to plan water projects to serve the State's needs.

Federal plans to ameliorate competition for existing water supplies and conflict between water users by developing additional water resources within the Central Valley were formulated as early as 1874, when the Alexander Survey was submitted to a special board appointed by President Grant. This report noted areas of water abundance and deficiency, and recommended that a series of dams be built on tributary streams along the foothills of the valley. In addition to dams, canal systems were to be located along both sides of

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the Sacramento and San Joaquin Rivers. The survey also recommended the formation of a State Engineer's office, which was established by the California Legislature in 1878. More than 20 significant actions by the State and Federal Governments between 1850 and 1917 also affected water development in the Central Valley.

A plan for water storage and conveyance was proposed in 1920 by Colonel Robert Bradford Marshall, who was then Chief Geographer of the U.S. Geological Survey, acting in a private capacity. Marshall's plan, as modified, became a basic framework around which California's State Water Plan and the initial features of the Federal Central Valley Project were later designed. Water development planning proceeded at an accelerated rate following publication of the Marshall Plan; between 1920 and 1933, some 20 additional investigations, legislative acts, and other significant activities related to water development in this area occurred.

The California Central Valley Project Act, passed by the State Legislature in 1933, authorized construction of the State Central Valley Water Project, with financing by public bond issue. Although approved by the Governor on August 5, 1933, the Act was delayed from going into effect by an approved State referendum petition which required a vote of the electorate. The Act survived the election, which was held in December 1933, but due to difficulty in marketing the bonds, the Project could not be undertaken by the State. After failure of repeated attempts by the State officials to obtain Federal grants or loans to aid in financing of the Project, requests were made to the Federal Government to undertake its construction.

The Rivers and Harbors Act of 1935, approved August 30, 1935, authorized construction of the initial features of the Central Valley Project by the U.S. Army Corps of Engineers. Soon afterward, on September 10, 1935, $20 million was transferred, by order of President Franklin D. Roosevelt, from the Emergency Relief Act funds to the Department of the Interior for construction of Friant Dam and other features of the "initial" Central Valley Project.

This action was followed by many additional congressional authorizations with the last one being in 1976. Many features of the Project have been completed, others are under construction, and still others have not yet been initiated.

The San Luis Unit was developed jointly by the U.S. Bureau of Reclamation and the California Department of Water Resources. San Luis Dam, Reservoir, and certain other facilities are used by both agencies, which shared the cost in proportion to the use by each (45 percent Federal,

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55 percent State). Additionally, each agency constructed facilities used by it alone which were not included in the cost-sharing arrangement.

The U.S. Army Corps of Engineers constructed Folsom, New Melones, Hidden, Buchanan, and Black Butte Dams which were incorporated into the Central Valley Project in accordance with authorizing legislation. All other features of the Project were constructed by the U.S. Bureau of Reclamation. All features are under operational control of the Bureau.

From its inception and formulation, the Central Valley Project has been a single project in concept, design, and operation; it functions as an integrated whole, not as a grouping of separate or independent units. The authorizing acts are replete with language demonstrating that Congress intended it as a single, interrelated, and integrated project from its beginning.

The Solano and Orland Projects, also built by the Bureau of Reclamation in the Central Valley Basin are not part of the Central Valley Project. The State of California's State Water Project, several other facilities built by the U.S. Army Corps of Engineers, and numerous private and municipally owned water-resource developments are also located within the basin. Some of these are influenced by or interrelate with the Project system; however, this report concerns only the Federal Central Valley Project.

## NEED FOR WATER TRANSFER

The climate and soil of the Central Valley make it one of the world's most productive agricultural areas. Water supplies within the Central Valley Basin, however, occur neither seasonally nor geographically in accordance with their needs. Specifically, the San Joaquin Valley contains about two-thirds of the agricultural land, but receives only about one-third of the water, while the Sacramento Valley has one-third of the land and two-thirds of the water. Also, the precipitation occurs mostly in the winter, leaving the long growing season with practically no rainfall. Moreover, heavy winter rains and spring snowmelt, if uncontrolled, would result in extensive and severe flooding.

Water transfer plans were eventually effected. Although local supplies had been developed and exploited in limited areas long before the interbasin transfers occurred, these efforts did nothing to resolve the major problem of Nature's imbalance between land and water supplies. Consequently, while large amounts of freshwater flowed to the ocean, vast acreages of high quality land in need of a water supply were not cultivated because water for irrigation was not available. Also, the threat of devastating floods was a

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constant peril, while much of the land already irrigated suffered from an insufficient or precarious water supply.

Overdrafting of ground water caused the ground-water table to be lowered at alarming rates in many places. Even with the limited developments, withdrawals of ground water exceeded the availability of local dependable water resources. Some lands were forced out of production or suffered frequent, heavy agricultural losses in drought years.

Upstream impoundments and river diversions for localized use contributed to seawater intrusion into the Sacramento-San Joaquin Delta during dry seasons, damaging crops and agricultural land, and contaminating municipal and industrial (M&I) supplies. The idea of transferring surplus water from the northern to the southern valley was long studied as a means to alleviate these problems.

## PROJECT PLANS

Early concepts of water transfer from the northern to southern portions of the Central Valley envisioned a large dam on the Sacramento River near where Shasta Dam was constructed, as well as other dams at high elevations for storage of surplus flows from the mountains. High-line canals, which would encircle the valley with gravity flow from the reservoirs and deliver northern water to the arid lands of the south, were contemplated.

The first aspect of this concept--the construction of storage reservoirs to control and regulate surplus flows--was embodied in later plans which were authorized and developed as initial features of the Central Valley Project. The initial proposal for gravity deliveries from high-line canals encircling the valley, however, was subsequently modified. Instead, water supplies controlled through storage in northern reservoirs were to be allowed to flow along natural watercourses to the Sacramento-San Joaquin Delta from which they would be lifted by a pumping plant into the headworks of a high-line canal in the foothills of the Coast Range mountains. The water was then to flow by gravity to a connection point with the San Joaquin River in the central San Joaquin Valley.

Simultaneously, San Joaquin River water supplies were to be stored and diverted by an upstream dam in the foothills of the Sierra Nevada into two high-line canals for gravity service to lands along the east side of the central and southern San Joaquin Valley. The northern water delivered through the Coast Range canal would be exchanged with San Joaquin River water diverted by the upstream dam. Electric power generated by the release of water through the powerplants, as adjuncts to the

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reservoirs, would provide the energy for pumping from the Delta. Power generated in excess of project pumping needs was to be sold commercially to help defray costs of the facilities, in accordance with provisions of Reclamation Law.

As previously explained, the first authorization of a Federal Central Valley Project was by the Act of August 30, 1935, and Executive Order of September 10, 1935. The project was reauthorized for construction by the Secretary of the Interior and made subject to Reclamation Laws by the Rivers and Harbors Act of 1937. The 1937 act also provided that the dams and reservoirs should be used, first, for river regulation and improvement of navigation and flood control; second, for irrigation and domestic uses; and third, for power. This act placed the Central Valley Project under the entire "umbrella" of Reclamation Law. A chronology of subsequent Central Valley Project authorization acts and completion dates of various unit additions is presented in Table 1.

Total capital expenditures for the project, accumulated over the past four decades since construction began, amount to approximately $2.4 billion. They include costs of features constructed by the U.S. Army Corps of Engineers which have been operationally and financially integrated into the Central Valley Project system. Total capital costs of the project, upon completion of the presently authorized features, are expected to exceed $5 billion. Associated operation, maintenance, and replacement expenses currently approximate $31.5 million annually.

## TABLE 1. CHRONOLOGY OF CENTRAL VALLEY PROJECT AUTHORIZATION

| Authorizing act | Date | Division or unit | Major features | Major construction completed |
|---|---|---|---|---|
| 1. Rivers and Harbors Act of 1937 | August 26, 1937 | Initial features | Shasta, Friant, and Keswick Dams, Tracy Pumping Plant; Delta-Mendota Canal; Madera and Friant-Kern Canals; Contra Costa Canal and facilities; Delta Cross Channel; power facilities; fish hatchery. | 1951 |
| 2. Rivers and Harbors Act of 1940 | October 17, 1940 | Initial features | Reauthorized features listed above and added irigation distribution system. | 1950's & 1960's |
| 3. American River Division Authorization Act | October 14, 1949 | American River Division | Folsom Dam; Nimbus Dam; power facilities; Sly Park Dam and facilities; fish hatchery. | 1955 |
| 4. Sacramento Valley Irrigation Canals Authorization Act | September 25, 1950 | Sacramento Valley Canals Unit | Red Bluff Diversion Dam; Corning Canal and Pumping Plant; Tehama-Colusa Canal and fish spawning facilities; irrigation distribution systems. | Not completed |
| 5. Grasslands Development Act | August 27, 1954 | Grasslands Waterfowl Management | Wells and drainage recovery facilities; revised CVP operations. | 1955 |
| 6. Trinity River Division Authorization Act | August 12, 1955 | Trinity River Division | Trinity Dam; Lewiston Dam; Clear Creek and Spring Creek Tunnels; 4 powerplants; transmission facilities; fish hatchery. | 1964 |
| 7. San Luis Unit Authorization Act | June 3, 1960 | San Luis Unit | San Luis Dam; pumping-generating plant; O'Neill Forebay and pumping plant; San Luis Canal; Pleasant Valley Canal and Pumping Plant; irrigation distribution system. | Not completed |
| 8. Rivers and Harbors Act of 1962 | October 23, 1962 | New Melones; Hidden and Buchanan Projects | New Melones Dam; Hidden Dam; Buchanan Dam. | 1981 |
| 9. Auburn-Folsom South Unit Authorization Act | September 2, 1965 | Auburn-Folsom South Unit | Auburn Dam; Folsom South Canal; Sugar Pine Dam; Foresthill Conduit; County Line Reservoir; Folsom-Malby Conduit. | Not completed |
| 10. San Felipe Division Authorization Act | August 27, 1967 | San Felipe Division | Pacheco Tunnel; Santa Clara and Hollister Conduits; pumping plants. | Not completed |
| 11. Black Butte Integration Act | October 23, 1970 | Black Butte Project | Black Butte Dam. | 1963 |
| 12. Reclamation Authorization Act of 1976 | September 28, 1976 | Allen Camp Unit | Allen Camp Dam; diversion dam; conduits; wildlife refuge. | Not completed |



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# Chapter 2

## project operations

### BASIC PRINCIPLES OF OPERATIONAL INTEGRATION

The basic operational objectives are to manage all Project features in a way that will best satisfy all responsibilities and authorized purposes of the Central Valley Project. As previously outlined, many units or components of the Project have been authorized over the past four decades. Each authorizing statute has expressly provided for the operational and financial integration of all Central Valley Project facilities. The objective of such legislative provisions has been to achieve the optimum efficiency and effectiveness of Project operations to best serve the widely scattered areas of need and all Project beneficiaries.

Special designs for reservoir storage controls, water releases, hydropower generation, river regulation, major water exchanges, and other operational criteria have been developed. Designs for flood control levels are independent of other requirements. Other achievements, such as fish and wildlife enhancement, navigation improvement, water quality control, and enriched recreational opportunities, also result from careful advance planning and the operational integration of many diverse and widely separated Project units.

### MANAGEMENT PLANS AND OPERATIONAL CRITERIA

Operation of the Project is monitored, and some features are controlled, out of the Central Valley Operations Center located at the Regional Office in Sacramento. Five field offices located in Redding, Willows, Folsom, Tracy, and Fresno carry out the operational activities in their respective areas. An elaborate communications and control system network has been developed between the central office and the field offices, and with other Federal, State, and local agencies so as to foster the integrated and efficient operation of all the Project features.

Operated as a multipurpose development, present Central Valley Project features include: some 20 reservoirs with a combined storage capacity of approximately 11 million acre-feet; 8 powerplants and 2 pumping-generating plants with a maximum capacity of about 1.8 million kilowatts; approximately 500 miles of major canals or aqueducts and

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other associated facilities; and an extensive power transmission grid. The Western Area Power Administration now operates the power transmission facilities.

Basic to the control of water and power is the storage of surplus water supplies during periods of heavy precipitation and snowmelt runoff. These supplies are subsequently released to river systems and canals in a pattern designed to best meet the various water and power demands throughout the year. An operational year has two periods, each with very different characteristics and goals. The first is the flood-control season--generally November through April--when reservoirs are operated to minimize flood damage and to store the excess winter runoff for use during the remainder of the year. The second period--extending from March through October--comprises the irrigation season, during which Central Valley Project reservoirs are operated as a single integrated whole to meet the irrigation and M&I demands, provide water quality control, navigation, fishery improvements, and the recreational enhancement objectives of the Project. During the entire year, hydroelectric power is an important product of Project operations. Careful conjunctive operations optimize hydropower production potentials, but the authorizing legislation relegates power to a lower priority than the flood control, navigation, and water service functions.

As previously indicated, the reservoirs are operated so as to achieve optimum flood control benefits during the winter months. Shasta Dam and Reservoir (Shasta Lake) serve as a good illustration of this principle. Shasta is one of the major storage reservoirs in the Central Valley Project system in which flood control is a specifically authorized, first priority, Project function. The U.S. Army Corps of Engineers develops the flood protection criteria controlling reservoir operational objectives during the flood season. These criteria for Shasta Lake provide for reservation of storage space, as appropriate, to impound floodflows and make releases to the Sacramento River at levels which can be controlled within the constructed levee system. Higher maximum flows are set on lower reaches of the river system to accommodate inflow from uncontrolled tributary drainage areas downstream.

Historical evidence indicates that precipitation during December and January usually requires maximum flood control space reservations in reservoirs. Thus, the prime objective is to draw Shasta Lake storage down approximately 1.2 million to 1.4 million acre-feet by early December. The storage space made available by this drawdown permits operational control of floodwaters from winter storms. In order to meet flood control objectives during major storms, water releases at

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Shasta are sometimes reduced to zero to minimize downstream flooding during periods of peak tributary inflow. After peak storm flows recede, releases from Shasta are increased to evacuate space needed to store inflows from later storms.

During the early spring months, the threat of major storms lessens, and the reservoirs are allowed to start filling. This process commences in February or March and the reservoirs normally reach maximum storage for the year in late May. At this point, the second phase of the operational sequence commences. Irrigation and other water demands begin to build up toward summer peaks which occur in either July or August.

Some Central Valley Project reservoirs, such as Trinity and Whiskeytown, do not include flood control as an authorized Project function, but are operated so as to help reduce flood damages whenever possible, as an incidental consideration. Whiskeytown Reservoir is normally drawn down about 40,000 acre-feet during the flood control season to provide some storage space to help reduce flood peaks from Clear Creek. This flood control operation and the associated benefits are achieved without detrimental effects on other authorized Project purposes.

During the irrigation season, major operational emphasis focuses on the Sacramento-San Joaquin Delta. Releases from Project reservoirs attempt to meet the following demands for Project water:

1. Water quality control in the Delta.
2. Irrigation supplies for the Sacramento Valley from Redding to Sacramento.
3. Irrigation supplies for the Delta.
4. Irrigation supplies for the San Joaquin Valley.
5. Navigation control with minimum flow requirements set at Wilkens Slough on the Sacramento River.
6. Municipal and industrial water supplies.
7. Water rights obligations of the Project.
8. Minimum downstream fishery requirements below Nimbus and Keswick Dams.

A base flow from upstream storage at Shasta and Trinity Dams is required to meet: navigation depths in the Sacramento River; fish and wildlife enhancement; water rights obligations; irrigation and M&I demands; and the Project's share of the outflow required to protect against salinity intrusion in the Delta. Folsom Dam releases are made to augment the Shasta-

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Trinity inflow to the Delta and for recreational and fishery improvement along the lower American River. Because Shasta-Trinity water supplies require about 5 days to reach the Delta, any emergency releases necessary to avoid possible adverse salinity intrusions are made from Folsom Dam. Such releases reach the Delta in less than 24 hours.

During the critical summer period, when inflow to the Delta must be balanced to satisfy variable demands, there is need for special monitoring of salinity levels at selected stations within the Delta. Special computer systems are used by the Bureau and the California Department of Water Resources to monitor such stations in order to satisfy this important requirement.

Varying amounts of Project water are pumped from the Delta at Tracy Pumping Plant, on a year-around basis. During the summer these water supplies are used to meet irrigation demands along the Delta-Mendota Canal and from the Mendota Pool on the San Joaquin River. During the winter, excess water supplies in the Delta are pumped at Tracy into the Delta-Mendota Canal and eventually into San Luis Reservoir for storage. The water supplies from San Luis Reservoir are released during the summer to meet the Federal share of irrigation demands along the San Luis Canal. Eventually, water transported through this reservoir and other associated facilities will serve the Santa Clara, Hollister, and Watsonville areas.

Most of the deliveries to the Mendota Pool are made for irrigation purposes to satisfy prior water rights on the San Joaquin River. Before initiation of Central Valley Project operations, water was diverted to these areas from the San Joaquin River, but the demands are now met by importations through the Delta-Mendota Canal. In turn, water supplies from the San Joaquin River, once used in these areas, are now stored at Friant Reservoir (Millerton Lake) and diverted into the Friant-Kern and Madera Canals for delivery to areas in the central and southern portions of the San Joaquin Valley. Irrigation districts integrate Project water supplies with ground water to provide optimum service to one of the most productive agricultural areas of the world.

Central Valley Project operational activities, during both the flood and irrigation seasons, require careful and intricate coordination with other agencies. During the flood season, the Bureau of Reclamation participates as a member in a joint Federal-State River Forecast Center in Sacramento. Weather, river stage, and reservoir inflow forecasts are constantly available from this center. The Bureau is also a member of a multiagency cooperative snow survey effort which assembles snowfall data needed to make

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watershed runoff forecasts. During summer months water operations are coordinated with those of California Department of Water Resources in a joint effort to maintain desirable water quality conditions in the Delta.

Meetings are held throughout the project area, at which public interest groups are invited to participate in order to improve coordination of Project operations. Such meetings are designed to acquaint local interests with specific operational problems involved, or to solicit their input, as appropriate, in the consideration of possible Project operational improvements.

Although brief, the foregoing summary identifies some of the major operational criteria which are pursued in an effort to optimize Central Valley Project accomplishments for the broad public interest. As additional units are constructed, and added to the Project, operational criteria and management plans will be changed to properly integrate the additional units into the enlarged system. The fundamental concepts and objectives are to establish and modify Project operational criteria as required, in a manner which will best serve all authorized functions, and, at the same time, protect prior water rights, satisfy water quality standards, and meet other priority requirements imposed upon the Project.

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# Chapter 3

## physical accomplishments

### BACKGROUND

A major purpose of this report is to identify the kinds and magnitudes of typical Project accomplishments and provide a reasonable expression of the economic and social impacts which can be attributed to the Project. The Central Valley Project water supply varies from year to year depending upon precipitation and water storage carried over from prior years. The levels of water production reflect the capability of completed Project facilities and coordinated operation of Central Valley project and California State Water Project facilities.

The Central Valley Project provides irrigation and municipal and industrial water service. It also produces commercial power, and provides flood protection, navigation, fish and wildlife, waterfowl conservation, and recreation benefits. In addition, the Project furnishes large quantities of water to satisfy water rights which were threatened by its construction, and meets other recognized prior demands such as fish flows, wildlife mitigation, and water quality maintenance. Some of these, such as satisfaction of water rights and water quality needs, represent "costs-of-doing-business," and are not properly creditable as Project accomplishments. However, other uses or commitments represent very real enhancements and should be recognized as contributions of the Project even though physical and monetary effects are difficult to measure.

One measurement of Central Valley Project accomplishments is an analysis of its water production capabilities during a water-short period such as the 1928-34 drought. During a comparable period, with current demands and existing facilities, the Project could deliver over 3.8 million acre-feet of water per year to satisfy prior water rights. Additionally, almost 4.0 million acre-feet could be marketed to water user organizations throughout the Central Valley for irrigation and M&I service.

In addition to the above deliveries to water users, the Project would also provide more than 6.5 million acre-feet annually to accommodate fishery flows, serve navigational needs on the Sacramento River, and meet water quality objectives. Typically, water released from Central Valley Project reservoirs serves many purposes before reaching its final destination. For example, water from Shasta Lake

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serves fishery and navigational needs in the Sacramento River as it travels downstream; upon reaching the Sacramento-San Joaquin Delta it helps to satisfy Delta water quality objectives or is available for delivery to farms in the San Joaquin Valley or the homes and industries of Contra Costa County.

In addition to recounting historical values, it is considered desirable to illustrate the general order of current project achievements for a recent year for which essential data are readily available. The year 1978 has been selected to serve this purpose. However, it should be noted that while 1978 represented a desirable point of measurement for some Project effects, it was not for others. The most severe drought in history occurred in 1976 and 1977, and although excessive spring runoff conditions prevailed in 1978, the amounts of Project water delivered in that year were somewhat below normal. For that reason, the values shown for 1978 are considered conservative as compared with the long-term averages.

Millions of persons benefit directly or indirectly from the many Project services. During 1978, about 908,000 persons benefited directly from Central Valley Project water service, including about 107,000 residing on 21,500 farms which received irrigation supplies from the Project. The average farm size was about 112 acres. About 527,000 persons benefited from direct M&I water service, while the remaining 274,000 benefited from other types of Project services. Annual water deliveries for irrigation and M&I for 1951-80 are presented graphically in Exhibit 1.

During the 5-year period 1974-78, which included 2 severe drought years plus 2 above normal water years, Central Valley Project hydroelectric plants generated electric energy equivalent to the amount which would otherwise have been produced by burning 42 million barrels of oil in fossil-fuel fired thermal generating plants. All of the Project's pumping energy needs were supplied by its powerplants. About 50 municipalities, districts, cooperatives, and governmental agencies were also provided with power from the Project. In excess of 1 million persons are provided electrical energy from Central Valley Project hydropower facilities.

Flood control, navigation, fish and wildlife, and recreation accomplishments of the Project also benefit many thousands of persons. The major Project effects identified above are discussed in greater detail in the remainder of this chapter.

## IRRIGATION

### General

After meeting a demand of about 2.5 million acre-feet for water rights and other

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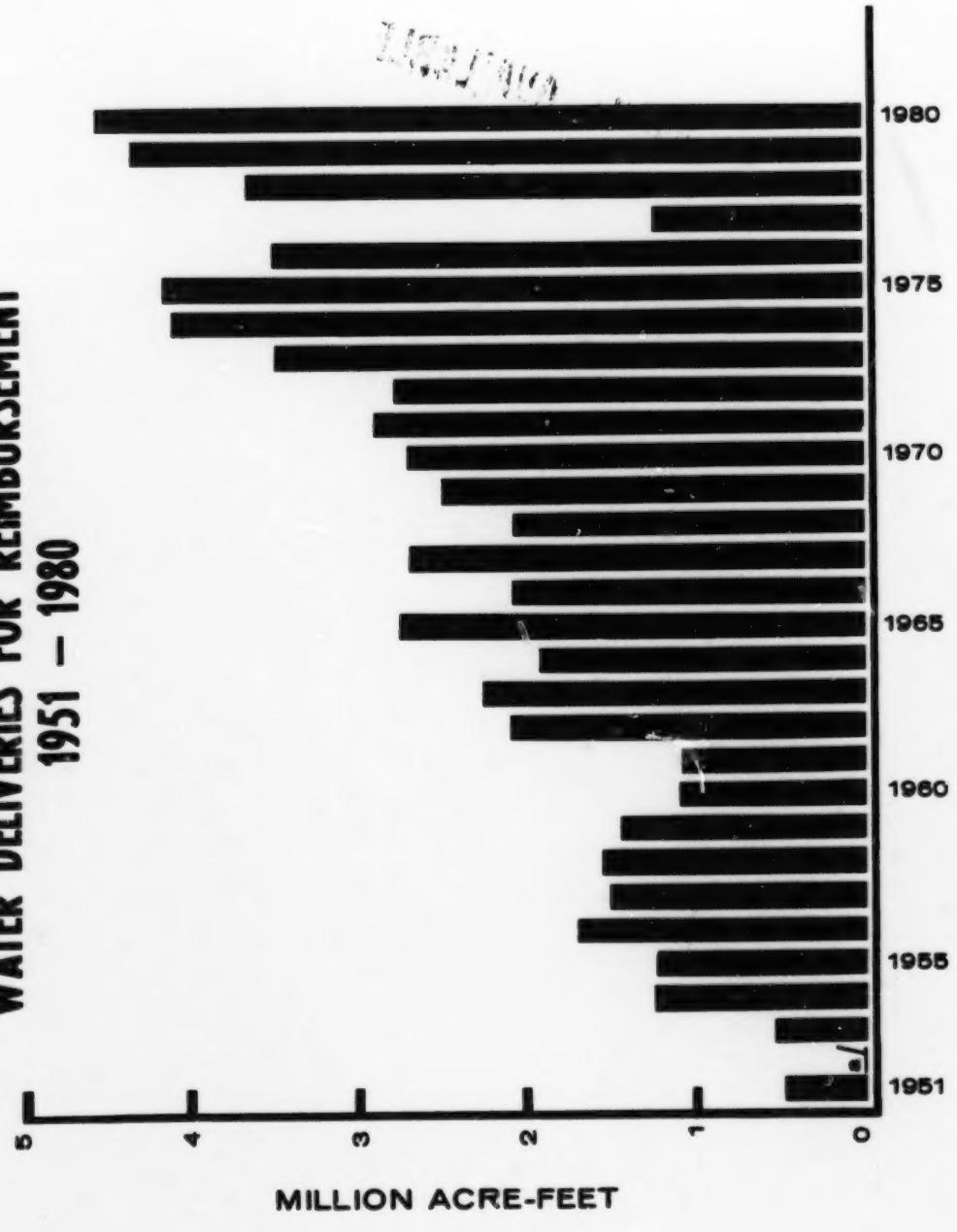
EXHIBIT 1

# CENTRAL VALLEY PROJECT
# WATER DELIVERIES FOR REIMBURSEMENT
# 1951 – 1980

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authorized purposes, the Central Valley Project delivered about 3.4 million acre feet of irrigation water to farms in 1978. This provided a full or partial irrigation supply to about 2.1 million acres which produced crops valued at about $1,644 million. If all project water had been used to provide a full supply (rather than a combination of full and supplemental service), about 1.3 million acres could have been served.

The first Central Valley Project irrigation deliveries were made from the Contra Costa Canal in 1941. However, major service did not commence until the early 1950's when the Tracy Pumping Plant and Delta-Mendota and Friant-Kern Canals were completed. From this beginning of Project service through 1980, almost 63 million acre-feet of irrigation water were delivered.

Because the soils and climatic characteristics of the Central Valley make it one of the world's most productive and versatile agricultural areas when irrigation water is available, yields for most crops are uniformly and consistently high, exceeding national averages by wide margins. No other part of the country produces such a wide variety of crops in such abundance. Over 200 different crops are grown commercially, with at least 125 of these contributing significantly to the food supply and economy of the area, State, and Nation. Fresno, Tulare, and Kern Counties, all of which receive Central Valley Project water, are among the Nation's ten highest producers of agricultural commodities.

Crops grown in large quantities on service area lands include more than 20 types of vegetables; 20 fruit and nut crops; 12 field and seed crops; and 5 forage crops. The Project's share of production of major crops, as compared to the national totals, is depicted graphically in Exhibit 2.

## Service Areas

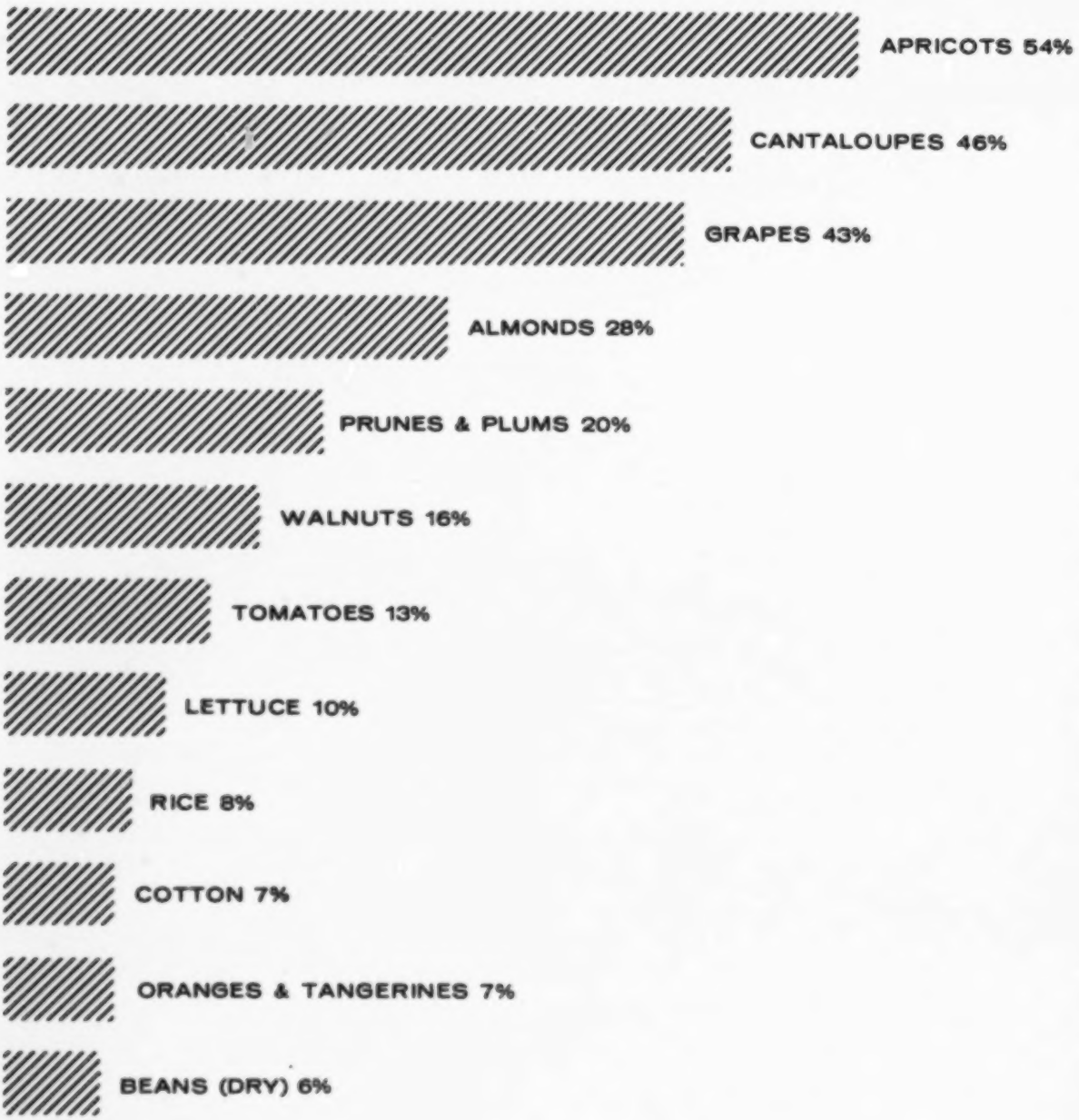
Irrigation supplies from the Central Valley Project serve four primary divisions and three smaller service areas. These areas vary in size and the amount of service provided, as well as in the varieties of crops grown and yields obtained. Soil and climate conditions in the northern part of the Central Valley generally do not support as wide a variety of crops as that found in the more southern areas. The various service areas are discussed below:

Delta Division. The primary irrigation service in the Delta Division is along the Delta-Mendota Canal on the west side of the northern San Joaquin Valley. Full and supplemental supplies of about 358,000 acre-feet of Project water were provided to more than 212,000 acres in this area in 1978. The soil and climate are generally excellent, and a

EXHIBIT 2

# PROPORTION OF UNITED STATES PRODUCTION OF MAJOR CROPS GROWN ON CENTRAL VALLEY PROJECT FARMS – 1978

( MEASURED IN GROSS CROP VALUE )

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wide variety of field crops, vegetables, fruits and nuts, as well as grain, forage, and seed crops, are grown. Cotton is not raised extensively in this area because of climatic factors, and most soils are not of a type suitable for rice production. Almost all other crops grown in the Central Valley, however, are adaptable to this area.

Friant Division. The Friant Division encompasses the service areas of the Friant-Kern and Madera Canals on the east side of the central and southern San Joaquin Valley. This is one of the world's foremost agricultural areas, with the soil and climate ideal for production of most crops. Consequently, a whole array of field crops, vegetables, fruits and nuts, grains, and forage crops are grown there. In 1978, the Central Valley Project delivered about 1,650,000 acre-feet of water to provide a full or supplemental irrigation supply to about 944,000 acres of land in the Friant Division. Three of the several counties receiving the water service (Fresno, Tulare, and Kern) are among the ten top producers in the Nation, as mentioned earlier.

West San Joaquin Division. The West San Joaquin Division is located on the west side of the central San Joaquin Valley, primarily in Fresno County. West San Joaquin is similar to the Friant Division service area in that it comprises part of one of the world's foremost agricultural areas. Its climate and soil are ideal for production of most crops, and the same wide array indicated for the Friant Division is also found in this division. In 1978, the Central Valley Project supplied about 924,000 acre-feet of irrigation water for both full and supplemental service to 526,000 acres of land in the West San Joaquin Division. The superb growing conditions and Central Valley Project irrigation supplies from both the Friant and West San Joaquin Divisions help make Fresno County the Nation's top producer of agricultural products.

Shasta Division. In 1978, the Shasta Division provided about 353,000 acre-feet of irrigation water to about 362,000 acres. This was primarily supplemental service to areas adjacent to the Sacramento River. The project water firms-up seasonal supplies to which the water users hold prior rights. Rice is the major crop grown in this area, but other crops, particularly fruits and nuts and other grains and forage, are also produced.

Other Divisions. The American River, Sacramento River, and Trinity River Divisions also supply irrigation water in their respective service areas; however, the quantities are comparatively small. In 1978, their combined service was about 112,000 acre-feet delivered to about 55,000 acres of land. Of this total, the Sacramento River

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Division, encompassing the Corning and Tehama-Colusa Canal service areas, accounted for 84,000 acre-feet of the water and 41,000 acres of the land. These amounts are expected to expand rapidly with completion of the Tehama-Colusa Canal and the associated distribution systems. The San Felipe Division, when completed, will provide about 72,000 acre-feet of irrigation water annually for Santa Clara, San Benito, Monterey, and Santa Cruz Counties.

### Reduction of Ground-water Overdraft

Ground-water overdrafting causes supplies to disappear, or the levels to be lowered to depths where pumping for irrigation is no longer feasible. Diminishing ground water also causes land subsidence in some areas, wherein land surfaces settle as water supplies are depleted, which in turn results in misalignment of canals, roadways, well casings, and pipelines. This is a major problem of increasing concern.

Subsidence damage had been occurring at alarming rates in some areas, particularly in the West San Joaquin Division, before the importation of Project water. In most areas served by the Central Valley Project, ground-water overdrafting has almost disappeared, thus halting the subsidence damages and the continuing need to drill wells deeper and deeper and the additional cost incurred for energy needed to pump from increasingly greater depths. However, many "nonproject areas," forced to rely almost solely upon ground water for their irrigated agriculture, are continuing to suffer the effects of constantly lowering water tables. It has been variously estimated that ground-water extraction for the entire San Joaquin Valley still exceeds recharge by between 1.0 and 1.8 million acre-feet annually.

## MUNICIPAL AND INDUSTRIAL WATER SERVICE

### General

Approximately 152,000 acre-feet of Central Valley Project water were furnished to communities for M&I use in 1978. The largest share of the water was delivered through the Contra Costa Canal to the cities of Martinez, Antioch, and Pittsburg, and to a large industrial complex comprised of steel, oil, rubber, paper, and chemical plants. The cities of Redding, Roseville, Placerville, Sacramento, Fresno, and Coalinga also receive a portion of their water needs from the Central Valley Project. The East Bay Municipal Utility District and Sacramento Municipal Utility District have entered into long-term contracts for Central Valley Project water to supply their future needs.

From the beginning of Project service through 1980, about 3.1 million acre-feet of M&I water had been delivered.

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The various areas receiving M&I service are discussed in the following paragraphs.

Delta Division

The Central Valley Project provided almost 65,000 acre-feet of M&I water in the Delta Division in 1978. Almost all of the Delta Division service was made through the Contra Costa Canal system to several cities and a large industrial complex in Contra Costa County.

Service from Contra Costa Canal commenced in 1941. When designed and constructed, it was expected to provide primarily irrigation water service. However, rapid municipal and industrial expansion in Contra Costa County, following World War II, soon indicated that the canal would be utilized primarily for M&I water service, with only minimal deliveries for irrigation purposes. Passage of time and operational experience prompted design modifications so the canal could better serve the M&I function.

The Short-Cut Pipeline was built to bypass a large oxbow in the canal which had been originally incorporated into the system design to provide this area with irrigation service. Since little irrigation demand developed in the area, the long loop was bypassed in order to improve reliability and reduce conveyance system losses. Contra Loma Dam and Reservoir were also added to improve reliability and provide for peaking requirements of the Contra Costa Canal system.

American River Division

The Central Valley Project provided over 39,000 acre-feet of municipal and industrial water in the American River Division in 1978. The service was to several cities and special districts, including the cities of Sacramento, Roseville, and Placerville, the San Juan Suburban Water District, and other suburban areas. The Project supply supplements the city of Sacramento's water rights and also provides for the city's future expansion needs. Additionally, Project water flowing down the American River below Folsom Dam percolates into the underground aquifers. This helps to replenish ground-water supplies, which are heavily relied upon to serve highly urbanized areas adjacent to the river.

Friant Division

The Central Valley Project provided more than 35,000 acre-feet of M&I water in the Friant Division in 1978. This service was mostly to the city of Fresno, but also included a number of smaller communities in the area. Service to Fresno is provided by an exchange arrangement whereby Friant-Kern Canal water is delivered to the Fresno Irrigation District, which then refrains from pumping an equal amount of ground water, leaving it available for extraction by the city of Fresno.

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## Other Divisions

Lesser amounts of M&I water were also served to various communities in the Shasta, Trinity, and West San Joaquin Divisions in 1978. Also the Auburn-Folsom South Unit, which is only partially completed, is now delivering industrial water through the Folsom South Canal to the Sacramento Municipal Utility District's Rancho Seco nuclear powerplant in southeastern Sacramento County.

A long-term contract has been executed with the East Bay Municipal Utility District for project M&I water service from the Folsom South Canal. However, the district will need to construct conveyance facilities necessary to transport the water to the East Bay service areas.

The San Felipe Division, which is now under construction, is designed to provide about 144,000 acre-feet of M&I water annually to service areas in Santa Clara, San Benito, Monterey, and Santa Cruz Counties. The project will also provide supplies for recharge of depleted ground-water aquifers and prevent further mining of ground-water supplies in Santa Clara County. Without additional import water supplies, ground-water pumping will exceed the long-term safe yield of the basin, resulting in possible land subsidence with its attendant problems and dislocation costs.

# HYDROELECTRIC POWER

## General

Various Central Valley Project authorization acts, particularly the Rivers and Harbors Act of 1937, provide that Project dams and reservoirs shall be used: first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and third, for power. Even though power production is last in the order of priority, the Project has generated more than 142 billion kilowatthours (kWh) of electric energy at its hydroelectric generation facilities since operation commenced. Varying annual precipitation results in uneven yearly production, but the average net generation exceeds 5.3 billion kWh per year.

All of the Project's water storage and power generation facilities are operated conjunctively to achieve optimum water and power accomplishments. The power is used, first, to meet the needs for project pumping. Under legislative provisions, power produced in excess of project-use requirements is offered for commercial sale, with first priority to "preference customers"--municipalities, other public entities, cooperatives, and governmental agencies such as military installations. Any remaining power is sold to privately owned industries or utility companies.

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The Central Valley Project enjoys a unique "banking" arrangement with the Pacific Gas and Electric Company (PG&E) under which excess power is sold to the Company under a provision that an equal amount may be repurchased at a later time when needed by the Project. The Company also "firms-up" the Project's hydropower production from its thermal plants which approximately doubles the dependable power capacity. The Project also benefits through a contract provision for transmission of Central Valley Project power over the Company's lines to serve preference customers.

The "banking" arrangement has also been very beneficial to the Company; the large Project hydroelectric plants integrated with the other PG&E steam and hydroplants have, because of their size, been an ideal adjunct to the Company in its day-to-day problem of meeting its peak loads and in stabilizing its system capacity. Further, the additional energy produced by the Project has been of considerable assistance to the Company in meeting the needs for power during a period of rapidly increasing demand.

About 30 percent of the Central Valley Project power production is used by the Project; the remaining 70 percent is sold to about 50 preference customers and to PG&E. About 1.1 million persons are benefited directly through the electrical service to preference customers. Some of these customers also have supplemental sources of supply; however, about 550,000 persons could be provided with a full supply by Central Valley Project power produced for commercial sales. This is approximately equivalent to a full supply for two cities, each the size of Sacramento.

Maximum generation capabilities (which may be higher than nameplate capacities) have been enhanced for most Project generators since their installation, and this upgrading process is continuing. The present capability and output of the Central Valley Project power generation facilities are:

| Powerplant | Initial operation (year) | Maximum capacity (kW) | Average annual net generation (million kWh) | Total generation to present (million kWh) |
|---|---|---|---|---|
| Shasta | 1944 | 551,600 | 2,146.7 | 77,281.2 |
| Keswick | 1949 | 90,000 | 469.3 | 14,548.3 |
| Folsom | 1955 | 210,000 | 622.7 | 15,567.5 |
| Nimbus | 1955 | 16,000 | 69.0 | 1,725.0 |
| Trinity | 1964 | 128,000 | 554.8 | 8,876.8 |
| New Melones | 1980 | 345,000 | -- | -- |
| Judge Francis Carr | 1963 | 145,000 | 665.5 | 11,313.5 |
| Spring Creek | 1964 | 190,000 | 803.7 | 12,859.2 |
| San Luis | 1968 | 186,670 | 44.3 | 531.6 |
| O'Neill | 1967 | 12,000 | 1.0 | 13.0 |
| Total | -- | 1,874,270 | 5,377.0 | 142,716.1 |



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The electric energy produced by the Central Valley Project has undoubtedly played an important role in meeting the demands of the rapidly growing population and of commerce, industry, and agricultural production of northern California. The Project has provided the energy to pump water to areas of dire need and supplied power required by farmers to pump ground water. It has also supplied electrical energy for residents and industries throughout the northern part of the State. Furthermore, hydroelectric production is a superb source of clean, nonpolluting, renewable energy. It replaces fossil fuels, which would otherwise be required for thermal powerplants, and permits the conservation or use of these scarce and more costly resources for other purposes.

Each of the Project's major power facilities is discussed briefly below.

## Shasta and Keswick Powerplants

Shasta and Keswick Powerplants, both located on the Sacramento River, were initial features of the Central Valley Project. Shasta Powerplant began operations in 1944 and Keswick in 1949. Keswick Reservoir serves as an afterbay to regulate the fluctuating flows through Shasta Powerplant. Shasta Powerplant has a maximum capacity of 551,600 kW; Keswick 90,000 kW.

## Folsom and Nimbus Powerplants

Folsom and Nimbus Powerplants were the second major generation unit added to the Central Valley Project system. They are located on the American River; Nimbus Reservoir (Lake Natoma) serves as an afterbay to regulate the fluctuating releases through Folsom Powerplant. Folsom and Nimbus have maximum capacities of 210,000 kW and 16,000 kW, respectively.

## Trinity River Division Powerplants

Trinity Dam and Reservoir (Clair Engle Lake), on the Trinity River, store water which is then diverted via Clear Creek Tunnel into the Sacramento River Basin. The total vertical drop from Clair Engle Lake to the Sacramento River is almost 2,000 feet. Power is generated at Trinity, Judge Francis Carr, and Spring Creek Powerplants as the water drops to the Sacramento River level at Keswick Reservoir. Additional generation is also realized from the higher flows passing through Keswick Powerplant. The Trinity River Division powerplants began operation in 1963-64. Trinity Powerplant has a maximum capacity of 128,000 kW; Judge Francis Carr Powerplant, 145,000 kW; and Spring Creek Powerplant, 190,000 kW.

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### San Luis and O'Neill Pumping-Generating Plants

San Luis and O'Neill are basically pumping plants which were constructed for the primary purpose of pumping water into off-stream storage reservoirs. However, when water is released from the reservoirs, it flows back through the plants and generates electricity in so doing. San Luis and O'Neill, placed in service in 1967-68, have maximum capacities of 186,670 and 12,000 kW, respectively.

### Power Transmission Facilities

The "backbone" transmission grid--initial features of the Central Valley Project--comprises the major components of the project transmission system. All later power additions were connected to these facilities. The integrated system consists of switchyards, high voltage transmission lines, and substations for delivery of power to project pumping plants and commercial customers. The Central Valley Project system is connected (intertied) to a Pacific Northwest transmission grid by an ultrahigh voltage line (500,000 volts); permitting power to be imported from or exported to that area.

In 1977, all Central Valley Project power transmission facilities were transferred to the Western Area Power Administration of the Department of Energy for operation and maintenance. Also, all future expansion of Project transmission facilities will be the responsibility of that agency.

## FLOOD CONTROL

### General

Flood control is the highest priority function of the Central Valley Project. This is entirely appropriate because human lives often are involved. During flood emergencies, the Project is operated to optimize flood protection in accordance with criteria established by the U.S. Army Corps of Engineers. Central Valley Project operations are coordinated with those of other major reservoirs in the Central Valley Basin.

No one knows the number of lives that have been saved by the flood protection operations of the Central Valley Project. Folsom Dam and Lake were credited with prevention of catastrophic floods in 1955 and 1964. These surely would have inundated large portions of Sacramento, and probably resulted in loss of life if the structures had not been in place. Flood control operations at Folsom also protect highly urbanized areas along the American River.

Shasta and Friant Dams routinely protect vast areas in the Sacramento and San Joaquin Valleys from devastating floods that occurred frequently in those watersheds before the

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dams were constructed. Other reservoirs built by the U.S. Army Corps of Engineers, State of California, and local water agencies also contribute to flood protection in the basin. Additionally, an extensive levee system built by the Corps, as well as channel improvements and other related types of works, have contributed significantly to the total flood protection effort. Untold human suffering has been averted and unknown numbers of lives saved, as well as hundreds of millions of dollars in property values protected, as a result of Central Valley Project flood control operations.

Flood Control Features

Shasta, Friant, Folsom, New Melones, Black Butte, Hidden, and Buchanan Reservoirs provide flood protection as an important element of Central Valley Project coordinated operations. Some of these features were constructed by the U.S. Army Corps of Engineers but have been integrated into the Central Valley Project by congressional mandate. All of these Project features include flood control reservations, i.e. empty storage space during the winter and spring runoff season to store floodwaters. After excessive flows fill or encroach upon the reserved space, it is emptied as soon as it is safe to do so, in order to provide protection from future floods.

NAVIGATION

Early congressional acts authorizing the Central Valley Project identified navigation as a high priority use of Project facilities. Considerable traffic plied the river for many years, however, this activity has since declined. More economical means have been developed to transport freight to and from the Sacramento Valley.

Traffic recorded by the U.S. Army Corps of Engineers in 1964, for example, showed that 1,677 towboats and 1,273 barges passed Sacramento on their way upstream. In 1964, most of this tow and barge traffic was moving petroleum, rice, safflower, and quarry rock. All of the activity in 1979--which had diminished to 130 towboats and 282 barges--was for transporting quarry rock for upstream bank protection. The Central Valley Project has little, if any, effect on navigation of ocean-going ships calling at the ports of Sacramento and Stockton, except for the contribution it makes to the increased tonnage of agricultural products available for shipment from those ports.

WATERFOWL CONSERVATION

Grasslands Area

Prior to construction of Friant Dam, the San Joaquin River overflowed intermittently over an area in the lower San

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Joaquin Valley known locally as the "grasslands". The land is considered to be "nontillable" because of its alkaline nature, but in "preproject" times, following high riverflows, it produced grass abundantly and created numerous ponds which provided excellent habitat for waterfowl. Surplus flows were also diverted from the San Joaquin River to these areas, primarily during the fall and winter seasons, when the water was not needed for irrigation. The United States was, and is, dependent to a large extent upon waterfowl propagation in this area to satisfy its obligations under migratory waterfowl treaties with Canada and Mexico.

When elimination of the "grasslands" water supply became imminent, under previously existing restraints, Congress authorized water service to these lands from the Central Valley Project. Facilities for recovery of drainage and ground water were also authorized to aid in provision of such a water supply. More than 1.5 million acre-feet of Project water have been provided to this area for waterfowl management purposes since 1951. A portion of the supply is used to irrigate grain crops in the area, which provide supplemental feed. The remainder is utilized for ponds and marshes needed for waterfowl resting and nesting.

Waterfowl Refuge Service

In addition to the grasslands area discussed above, the Central Valley Project also provides about 30,000 acre-feet annually to the Sacramento, Delevan, and Colusa waterfowl refuges located in the Sacramento Valley. As in the case of the "grasslands," the Project water is used both for irrigation of grain for feed, and ponding for resting and nesting purposes.

FISH AND WILDLIFE

Most Central Valley Project fish and wildlife accomplishments result from the creation of lakes and marshes and the operation of Project facilities to maintain streamflows and dilute toxin-laden waters. For example, releases are made from several Project reservoirs to protect and accommodate downstream fisheries, especially during critical spawning periods. Releases from Spring Creek Debris Dam, Shasta Dam, and Spring Creek Tunnel are coordinated in order to dilute toxic concentrations of copper and zinc from Spring Creek which enter the Sacramento River at Keswick Reservoir. These toxins have been suspected of killing fish during periods of high Spring Creek inflow; however, controlled releases from Spring Creek Debris Dam coordinated with Sacramento River flows result in concentrations which are less toxic to fish.

Central Valley Project operations maintain storage levels at Whiskeytown Reservoir during certain seasons to benefit spawning of kokanee

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salmon; water levels in Black Butte Reservoir are also controlled to protect crappie spawning each spring. Other fishery benefits include construction of facilities and provision of water supplies for fish hatcheries located below Shasta, Nimbus, and Lewiston Dams. The Project may also release up to 60,000 acre-feet of water into the San Joaquin River, at times of low flow, to remove an "oxygen block" that frequently develops near Stockton and prevents the migration of anadromous fish.

Central Valley Project operations also contribute to control and maintenance of proper water temperatures for fishery purposes downstream from Project reservoirs. For example, the powerplant intake facility at Folsom Dam is operated to provide suitable downstream temperatures for fall salmon spawning in the Nimbus Fish Hatchery and the lower American River. Movable shutters are operated to conserve colder water near the reservoir bottom for release in October and November of each year. These operations are coordinated with those of the California Department of Fish and Game. During extremely adverse conditions, such as the 1976-77 drought, other releases of colder water were made from Shasta and Folsom Reservoirs to improve conditions affecting fisheries.

Approximately 1.2 million angler-days of use were recorded at Central Valley Project reservoirs in 1978. The most active fishing locations are at Shasta, Whiskeytown, Folsom, San Luis, and O'Neill Reservoirs. The most active hunting areas are found near Shasta, Whiskeytown, Trinity, and Lewiston Reservoirs, and at wildlife management areas near Kesterson Reservoir and adjacent to Little Panoche and Los Banos detention dams.

## RECREATION

The Central Valley Project has made numerous high quality, water-based, recreational opportunities available to the general public. The most popular activities include boating, water skiing, rafting, swimming, fishing, hunting, picnicking, camping, horseback riding, bicycling, hiking, and photography. Participation in these activities has accelerated over the period of Project operation; in 1978 more than 10 million visitor days of use were recorded. Reservoirs and their surrounding areas were most heavily used; however, significant visitation also occurred at wildlife management areas, canal reaches having fishing access points, and at fish hatcheries.

Sightseeing, picnicking, and swimming were the most popular activities in 1978; boating also had a very strong appeal. Folsom Lake has an average of 90,000 to 100,000 boats launched there each year. From 900 to 1,000 boats per day may utilize the facilities

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during the summer months. Other lakes of the Central Valley Project system are also heavily utilized for boating. Shasta Lake actually supports more boats on high-use days than does Folsom, yet its total usage is less because Shasta is further removed from heavily populated areas.

The Central Valley Project also contributes to the maintenance of favorable water levels in stream reaches below Project reservoirs. The American River, in particular, supports a very high level of recreational activity which would not occur without the stabilizing flows made possible by Folsom Lake releases. Similar improvement in recreational use is attributable to streamflow augmentation by Shasta and Trinity Reservoirs operations.

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# Chapter 4

## economic impacts

### BACKGROUND

The economic impacts resulting from construction and operation of the Central Valley Project contribute significantly to the national economic goals. Chapter III described how millions of persons benefit directly or indirectly from irrigation and M&I water service, as well as the commercial power, flood protection, navigation, fish and wildlife, recreation and water quality control functions of the Central Valley Project. A portion of these effects can be measured monetarily, while others can only be evaluated qualitatively; however, all are very real, and significantly impact the economy of the area, the State and the Nation.

Over, above, and beyond the local readily recognized, direct benefits, are those of an indirect or intangible nature--many of which are widely extended throughout the national economy. For example, the development of water and power supplies affords new economic opportunities in agriculture and industry, which assist in supporting an expanding populace. California's population more than doubled between 1950 and 1980, resulting in vast increases in demands for food, clothing, and housing, as well as consumer goods and services of many kinds. New jobs were created to satisfy the increased demands. Associated economic activities and benefits occur not only at the local level, but also throughout the Nation via various channels of trade.

The increase in land values, stemming from additional irrigation development, diminished land subsidence, and stabilized ground-water basins, has broadened and stabilized the tax base. The basic wealth of irrigated agriculture and the tax revenues stemming therefrom could not be achieved without a reliable irrigation water supply.

Not to be ignored in the evaluation of Project impacts is the stimulation of trade from expenditures for wages, materials, and equipment necessary for construction and operation of dams, canals, powerplants, and the many other types of Project facilities. A substantial portion of the labor involved is "off-site," involving the manufacture of materials and equipment at many locations throughout the Nation. Major transportation values are associated with the movement of materials and supplies needed for construction activities. However, such

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transportation values will appear relatively insignificant when compared with the increased "two-way" flow of goods associated with enhanced economic activity resulting from Project development. Crops produced on Project farms have been valued at about $15 billion over the 10-year period 1971-80. This is about six times the total capital expenditures of $2.4 billion for Project facilities during the past four decades of construction. Economic impacts are discussed below by function.

IRRIGATION

Direct Irrigation Effects

The 21,500 farms receiving irrigation service described in Chapter III produced crops valued at $1,644 million in 1978. The net value of that output, after production expenses, was over $1,000 million, or about $46,000 per farm. The 107,000 residents of project farms enjoyed an average per capita income of more than $9,000 in that year, which compared favorably with California's average per capita income. This is particularly significant since income levels for other sectors of society are normally somewhat higher than are those for the agricultural sector.

Chapter III showed that about 1.3 million acres could receive a full irrigation supply from Project sources. It follows that, in the absence of the Project, the same number of acres would have eventually reverted to dry-farming operations as groundwater supplies were gradually depleted by overdrafting. In the Central Valley, the average value of irrigated land with a reliable water supply exceeds that of comparable land types having no water supply by about $3,000 per acre. It may be assumed, therefore, that Project irrigation service can be credited with retention of almost $4,000 million in land values that otherwise would have been lost if those irrigated lands had reverted to dry-farming operations.

Such losses would have been devastating to the economy of local areas through consequent reductions in their tax bases. Thousands of persons would have been displaced from their homes, necessitating relocation elsewhere. Many businesses, relying upon farm purchases and sales would have been forced to close or driven to bankruptcy. Thousands of jobs would have been lost, welfare payments increased, and crime rates and other problems associated with excessive unemployment would have multiplied into more serious proportions.

Indirect Irrigation Effects

In addition to the direct impacts of irrigation already discussed, many less tangible, but nevertheless real, benefits exist. Water developments create opportunities not only for new farms, but also for

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many interrelated activities. People living in an area such as the Central Valley must be clothed, housed, fed, and provided with services commensurate with the higher standard of living prevailing in the area.

For example, in this interrelated chain of economic activity, the grocer gains. Resulting benefits occur not only at the retail level; they also extend to the wholesalers, processors, and ultimately to producers at various locations throughout the country, whose food products are marketed through the grocer.

Many other trade and service industries are affected similarly. Clothing, building materials, hardware, household furnishings, agricultural implements, and numerous other items are purchased with income produced on Project farms. Some of these are produced on the West Coast, but the bulk of them are supplied by manufacturing establishments east of the Mississippi River--thus extending the benefits of Western development into the trade channels of other geographic regions of the Nation.

In addition to economic impacts stemming from agricultural production in the Central Valley, as discussed above, other impacts are induced by the same production. Industrial and business establishments gain from processing, storing, transporting, and marketing commodities produced on farms. The University of California Cooperative Extension Service recently completed an interindustry analysis of the Fresno region in which they concluded:

"...Agriculture accounted for about 21 percent of the sales and 24 percent of the household income in 1974. About 61 cents of each agricultural sales dollar were spent in the Fresno County region. A typical dollar increase in agricultural exports leads to an additional $1.39 increase in regional sales and incomes..."

If the Fresno region study findings are considered representative of the Central Valley Project service area, the $1,644 million in agricultural production value for project farms would generate about twice as much more in the economic chain from movement through normal trade channels. It is recognized, of course, that agricultural production stems from the combined effects of many factors other than irrigation (land, labor, capital, etc.). Irrigation water is but one of these; however, without it, very little crop production would result from the arid lands of California's Central Valley.

The value of foreign exports increased by about $512 million in 1978 as a result of production on Central Valley Project farms. This contributed significantly toward the United States effort to maintain a favorable balance of

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trade with foreign countries. In turn, a favorable balance strengthens the value of the United States dollar, in relation to other currencies, which results in lower costs for imported goods.

Other types of intangible benefits result from a large, stable agricultural base. For example, the Project provides water to the Central Valley, where a wide variety of crops is grown. These many crops provide a wider range of choices in planning family meals, thus contributing to a wholesome and nourishing diet.

In areas of low and irregular rainfall, irrigation provides stability to agriculture. This reliability aids the farmer by providing a more stable income which, in turn, reduces his risks and lessens chances of failure. Stabilized production also benefits the consumer by providing a steady flow of food products in the marketplace. A steady, reliable food supply contributes to long-term price stability. The United States enjoys an abundant food supply at a cost of less than 20 percent of the national income. The United States and Canada are the only major countries of the world that have such extremely favorable food cost-income relationships. Irrigation in the western United States and California, in particular, has made a significant contribution to this food supply; the Central Valley Project has contributed significantly in this achievement.

Employment Effects

Broadening of the agricultural base in the Central Valley provides increased opportunities for employment in many fields. Directly associated with agriculture, of course, is the number of people required on the farms in irrigating, planting, cultivating, and harvesting activities. The specialized nature of cropping in the Valley also creates thousands of jobs in packing and processing the various fruits, vegetables, and other commodities produced.

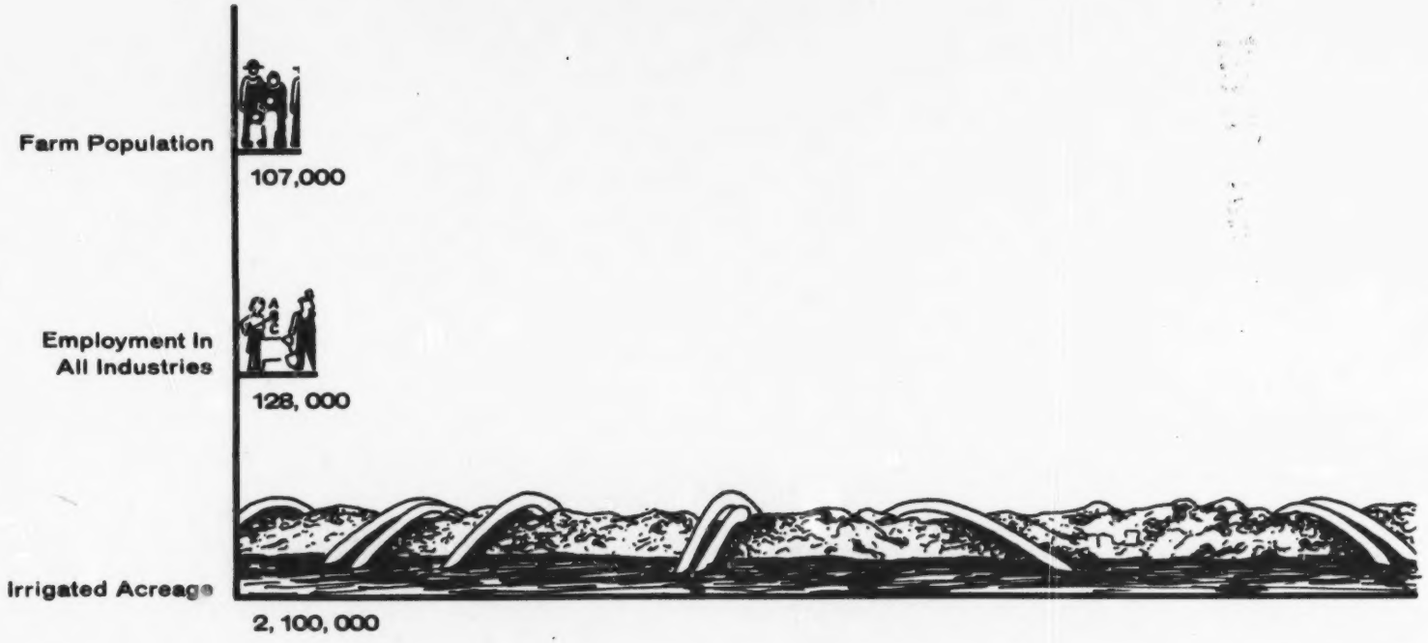
Additional opportunities are created in the so-called nonagricultural sectors, which are indirectly related to the agricultural economy. Included in this category are construction workers; employees in manufacturing plants; those connected with transportation, communication, utilities, wholesale and retail trade, finance, professional, and governmental services. The Central Valley Project generates sufficient wages and farm income to support the full-time employment of about 128,000 persons in these activities in addition to the 107,000 farm residents. (See Exhibit 3.) The off-farm employment is equal to about half of the entire labor force of the Fresno metropolitan area.

Tax Revenues

The Central Valley Project produces many millions of dollars in tax revenues each

EXHIBIT 3

# CENTRAL VALLEY PROJECT
# IRRIGATED ACREAGE, EMPLOYMENT, AND FARM POPULATION

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year. Various types of taxes include Federal and State income taxes, State sales taxes, property taxes, special-use taxes, and permits. Many others, including Federal transportation, corporation, manufacturers' excise, and other hidden taxes, also stem from Project activities. Dollar amounts derived from each of the various types of taxes are not readily available by specific areas. However, an indication of the magnitude of revenues resulting from certain tax components is evidenced in the following excerpt from a special and independent study undertaken by Dr. J. Gordon Milliken of the Denver Research Institute, University of Denver:

"...In 1977, the Central Valley Project stimulated enough economic activity to generate $357 million in Federal revenues, from personal and corporate income taxes and indirect business and excise taxes. Another $50 million in State and local income taxes was generated, although this estimate is based on an average tax rate for all states rather than on California alone. Although much of the project's economic activity occurs in California, the economic activity also spreads into other states where products are used and from which supplies are purchased..."

That same report points to the fact that 1977 was a drought year, and indicates that the total value of Central Valley Project output was 17.5 percent higher in 1978. Accordingly, the comparable tax contributions attributable to the Project would be substantially greater than those shown for 1977. Recent data indicate that the comparable tax revenues were about $756 million in 1979. The above estimates do not include State sales taxes or several of the other types identified above.

## MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Economic impacts resulting from M&I water service are difficult to evaluate, not only because of the variety of uses involved, but also because of the lack of agreement on "economic descriptors." The Dr. J. Gordon Milliken report, previously referenced, indicates that $1.8 million in personal income, corporate profits, and indirect business taxes were generated in 1977 by M&I water service from the Central Valley Project. From the time Project operations began through 1980, a total of 3.1 million acre-feet have been provided for M&I purposes. The economic impacts on the municipalities and industrial establishments which have been served, and also on all related channels of economic activity are significant.

## HYDROELECTRIC POWER

The hydroelectric power output of the Central Valley Project has a wide variety of

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uses. Economic impacts resulting from commercial power service are difficult to measure for the same reasons cited above for M&I water service. The effects from use of Central Valley Project power generation for Project use pumping are reflected in those values already discussed for irrigation and M&I service. The provision of Project power supplies to about 50 preference customers at relatively low, stable rates has highly significant economic impacts. However, a monetary evaluation of the effect cannot be readily determined.

Production of hydroelectric energy can be considered as a substitute or alternative for energy production from fossil fuels, such as oil, coal, and natural gas which are burned in thermal power plants. Central Valley Project hydroelectric generation averages about 5.3 billion kilowatthours of energy annually. Almost 9 million barrels of oil would be required to produce an equivalent amount of thermal electric power. [See Exhibit 4.] At 1980 prices, the annual cost of that much oil, or conversely, the value of Central Valley Project power, would amount to $214 million. Obviously, this represents a highly significant economic impact, not only to the water and power users, but also to the entire Nation because of the beneficial effect on the balance of trade (if it is assumed that the oil would have been imported). This Project accomplishment is especially significant in view of the precarious supply and volatile prices of imported fuel oil, and the depletion of domestic nonrenewable reserves. It is generally believed that future prices of fossil fuels will be much higher than those experienced in 1980. The value of Central Valley Project power should rise in proportion to the increases in fossil fuel prices.

FLOOD CONTROL

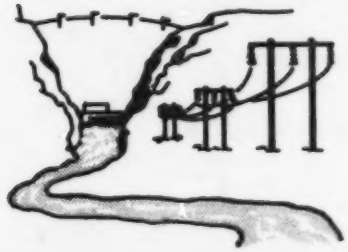
Total accumulative flood control benefits attributable to Central Valley Project facilities through 1980 have been estimated at about $375 million. Such estimates, developed by the U.S. Army Corps of Engineers, reflect price levels prevailing at the time of each major flood occurrence evaluated, and indicate the value of flood damages which would have occurred in the absence of the protection afforded by Project facilities. If such values were equated to current price levels, it would be reasonable to assume that the amount of flood control benefits would be much higher than the $375 million.

In addition to direct monetary flood control benefits, many others of an indirect and intangible nature also occur. The intangible effects contribute real and significant economic impacts, even though they are difficult to measure and evaluate. Loss of life averted, protection against water contamination and associated illness, and freedom

EXHIBIT 4

# CENTRAL VALLEY PROJECT
# HYDROELECTRIC ENERGY PRODUCTION

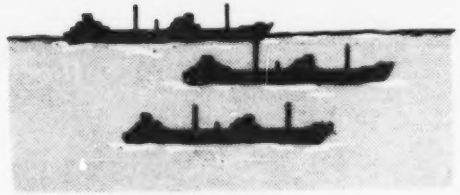
CVP HYDROELECTRIC GENERATION



5.3 BILLION kWh ANNUALLY

=

THERMAL ELECTRIC GENERATION



9 MILLION BARRELS OF OIL

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from anxiety and fear are important Project contributions which should not be overlooked or ignored.

RECREATION

Over the past 3 decades since the Project became operational, water-based recreational opportunities made available as a result of Central Valley Project development have attracted tens of millions of visitors. Variable water level conditions and other limiting factors influence the magnitude of visitor usage and also the type of recreational activities at Project recreational sites. Both amounts and types of use at the various locations fluctuate significantly from year to year. Chapter III of this report discussed some of the more extensively used Project recreational areas and the variety of recreational opportunities afforded. Average use has amounted to about 10 million visitor-days annually for the past several years. The following tabulation summarizes historical recreational use at Project sites during more than 20 years of operation:

Recreation Visitation
(millions of visitor days)

| | |
|---|---|
| 1959 - 4.2 | 1974 - 11.4 |
| 1960 - 5.0 | 1975 - 12.9 |
| 1965 - 7.5 | 1976 - 9.6 |
| 1970 - 7.2 | 1977 - 8.8 |
| 1971 - 7.5 | 1978 - 10.1 |
| 1972 - 6.8 | 1979 - 9.5 |
| 1973 - 7.5 | 1980 - 9.7 |

That the recreational benefits attributable to the Project are real and significant is unquestioned. However, the means and procedures for developing and assigning monetary values for them have been subject to considerable study, with no substantial agreement. The U.S. Water Resources Council has directed the use of $1.40 to $4.10 per visitor-day for evaluation of general recreation benefits in the formulation of plans for future water resource developments. If these values are used, the impact of recent average visitation (10 million visitor-days annually) would range between $14 and $41 million. Use of $3.00 per visitor-day as an assumed average value would result in about $30 million annually.

OTHER

Angler-day use of Project reservoirs is included in the recreation visitation discussed above. Monetary evaluation of fish and wildlife effects is difficult and elusive; consequently, no recent updating of such values has been undertaken for the Central Valley Project.

Project contributions to waterfowl conservation are real and significant. However, monetary evaluations are not available because of their intangible nature.

Project water supplies contribute to the maintenance of proper salinity conditions and other desirable water

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quality parameters in the Delta and at other strategic and important locations. Since such accomplisments do not lend themselves to monetary definition, no major effort has been directed to such evaluations.

Annual navigation benefits attributable to stabilized Sacramento River flow conditions were estimated at $1,260,000 by the U.S. Army Corps of Engineers in 1959. There has been no updating or revision of such benefit determinations since that time.

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# Chapter 5

## socioeconomic considerations

### GENERAL

The Central Valley Project has significantly influenced and affected the expansion and diversification of business and employment opportunities and standards of living in the areas that it serves. Sociologically the Project has contributed to changes in many population categories, e.g., number, age, origin, distribution, socioeconomic composition, and ethnic makeup. These factors have, in turn, influenced demands for housing and public services such as education, health care, and recreational facilities. The socioeconomic impacts have contributed in many ways, both tangible and intangible, to the standards of living and general well-being of Project beneficiaries.

#### Relief from Suffering and Anxiety

The problems and hazards associated with an undependable water supply, for either irrigation or M&I use, cause great anxiety and suffering in times of drought or shortages resulting from system unreliability. The limited levels of income associated with variable and undependable water supplies constitute severe limitations on the achievement of desired levels of living and "quality of life."

In seasons and areas of flood danger, the anxiety involved and damages incurred seriously disrupt and adversely affect normal socioeconomic activities as compared with those of other surrounding or adjacent areas which are more favorably located or protected from devastating floods. Flood protection afforded as a result of Central Valley Project construction and operation certainly contributes to greater peace of mind and psychological well-being of those persons protected. The Project can, in a real sense, be considered a "broad-coverage" insurance policy which provides protection to its beneficiaries from some of the hazards of weather and natural disaster.

#### Quality of Life and Social Well Being

The phrase "standard of living" encompasses both personal income and quality of life considerations. Western societies have long measured standard of living in terms of income levels. Current problems such as those associated with crime, urban sprawl, and environmental pollution certainly raise questions as to the validity of income measurements as a sole indicator of societal well-being. Suitable

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outlets for leisure time activities and favorable physical environment, in contrast with "creature comforts," have certainly become increasingly important.Central Valley Project development has contributed to quality recreational opportunities that vary in scope from fishing, hiking, and sightseeing to comprehensive recreational complexes at project reservoirs, such as Shasta and Folsom, which provide a rather full range of water-associated recreational activities. The Central Valley Project has thus provided relatively inexpensive access to vast outdoor recreational facilities which contribute to the physical and psychological well-being of major population segments, both locally and from points distantly removed.

An examination of income levels as a measure of personal well-being appears to indicate a major disparity between Central Valley Project areas and the State as a whole. However, recognizing that wages of workers employed in agriculture are lower than those of the general population, the disparity of income levels between the Central Valley and the State as a whole is placed in better perspective. Closer scrutiny of personal income data indicates that personal per capita income for the 24 Central Valley counties amounted to just over 80 percent of the State average for 1970. By 1975, the Central Valley average had risen to 88 percent of the State average. Improved economic conditions, stemming from Central Valley Project development, have contributed significantly to this improvement of personal well-being.

Population growth in Project service areas has created a need for more public services as well as a means to provide such services, e.g., a broader tax base. Public revenues have increased, as has the value of agricultural land, which is attributable to provision of adequate water supplies. Other beneficial Project effects include the support for additional business enterprises. The Central Valley Project has contributed significantly to an improved standard of living in the Project area and elsewhere. It has also provided recreational and environmental amenities, all of which contribute to "quality of life" and social welfare enhancements for Project beneficiaries.

## SOCIOECONOMIC EFFECTS

The Federal Reserve Bank of Kansas City, in recent studies evaluating the social impacts of water resource developments, concluded, in part, as follows:

". . . Another source of secondary benefits, due to external economies, . . . arises in the field of social overhead capital. Facilities such as schools, roads, utilities and other urban social capital may have excess capacity and thus be subject to

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decreasing costs as their use expands. The fuller use of social overhead capital is a legitimate secondary benefit attributable to a project. . . Another similar type of benefit which results may be termed 'dynamic or developmental.' Such benefits do not depend upon adjustments leading to more efficient allocations of a given stock of resources, but rather arise from the dynamic social engineering aspect of resource development. These benefits are based upon the development of more skilled labor and the introduction of advanced techniques and capital, which will convert underutilized resources of an area to optimal employment. . . Two other sources of secondary benefits falling into the category of dynamic effects of resources development projects are sociological as well as economic. The migration of population . . . reveals an area preference which is gradually moving the center of population westward. If such a movement continues the productivity of human resources, in the areas experiencing large population increases, will fall unless the population movement is accompanied by a transfer of capital and the careful development and husbanding of resources, including water . . the provision of employment opportunities in areas which offer the amenities of living which attract people to them increases satisfaction just as surely as any policy which enhances the gross national product as ordinarily measured."

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addendum

SUPPORTIVE FINDINGS

The extracts presented below are summaries drawn from three different reports, all of which are supportive of, and lend credence to, the findings previously discussed in this report. They are:

(1) Committee Print No. 11 (1956), entitled, "The Contributions of Irrigation and the Central Valley Project to the Economy of the Area and the Nation." Committee on Interior and Insular Affairs - House of Representatives, U.S. Congress.

(2) "The Bureau of Reclamation" by William E. Warne, published by the Praeger Library of U.S. Government Departments and Agencies, 1973.

(3) Summary Report entitled, "The Economic Impact of the Central Valley Project" by Dr. J. Gordon Milliken, Research Economist, Denver Research Institute, University of Denver. Presented at a symposium on Water Resource Development at Fresno, California, November 15, 1979.

Reference No. 1

Committee Print No. 11, deals with the same general subject as that addressed in this report. In submitting the report, then Bureau of Reclamation Commissioner Dexheimer stated in part as follows:

". . . The contribution of the irrigation aspects of the project and the contribution of irrigation in general in the eighteen counties of the Central Valley area attest to the importance and value of irrigation in providing opportunities in farming and all the associated industrial and corollary trades and professions with attendant high levels of living and extensive local interstate and intrastate business. . . . A more complete report will be possible when additional features of Central Valley Project are completed and in full operation."

The report concluded that the Project, in a single year, (1953) had:

". . . provided some 1,500,000 acre-feet of water, about 70 percent of the crop irrigation requirements of the 720,000 acres then served by the project. Value of crops and livestock attributable to project water in that year was estimated at $152 million, or about one-eighth of all cash farm income in the valley. The project farms and associated

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processing, packing, and transportation provided work for a maximum of nearly 40,000 workers. About 50,000 persons in the local communities were engaged in servicing industries. Resultant purchasing power included $35 million net income to project farmers and an estimated $54 million in wages to employees on farms and in collateral industries. This provided a market (estimated) for $40 million in automobiles, $10 million in farm implements, $13 million for apparel, $25 million for gasoline and $15 million in furniture, household equipment and home appliances, plus an estimated $7,300,000 paid in Federal personal income tax--about three times the amount paid for project water in that year. Farmers and their employees paid over $1,800,000 in State retail sales and personal income taxes, and some $2 million more in county property taxes than they would have without the project. The railroads hauled out 21,800 cars of agricultural commodities attributable to project water and hauled in 12,000 cars of merchandise from the rest of the Nation to farmers and others benefiting from the project, receiving an estimated $20 million in revenues.

"About 500,000 acres of irrigated land served by the project which would probably have reverted to dry-farmed land or pasture without project water, retained a market value of some $200 million more than they would have had without project water, and over $60 million in value had been added to dry lands furnished a full water supply by the project . .

"And all this had been accomplished by the expenditure, by the end of 1953, of some $400 million in planning and constructing the project, most of which will eventually be reimbursed from revenues from the sale of water and power. . ."

In submitting Committee Print No. 11 to the House Interior and Insular Affairs Committee, Chairman Clair Engle stated:

". . . It (the Report Committee Print No. 11) shows that the impact of Central Valley Project on the economy of the Central Valley and on the economy of the Nation already has been tremendous, even though the area to be served eventually is only partially developed. The initial features of the Central Valley Project have been completed for several years but during 1953, the year covered by the facts and figures of this study, the initial features of Central Valley Project were supplying only 52 percent of the water they will ultimately serve in the valley . . ."

Reference No. 2

Mr. William E. Warne is a former Assistant Commissioner - Bureau of Reclamation, Assistant Secretary - U.S. Department of the Interior, Director - California Department of Water Resources, and a world-

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renowned private consultant in the field of water resources development. In his book entitled, "The Bureau of Reclamation," Mr. Warne, in describing the Central Valley Project as one of the world's most outstanding water resource developments, asserted, in part, as follows:

". . . Among the many spectacular achievements of the Bureau of Reclamation, probably none outshines the Central Valley Project of California. From the acorn of the authorization in 1933 as a $170 million State water project the mighty oak has grown into a $1.3 billion Federal project [Currently this value exceeds $2.4 billion - Editorial note]. After four [now five] decades this project is still growing vigorously. And certainly no other project of the Bureau has been through such intensive controversy as has Central Valley Project. . . . The Bureau of Reclamation is the builder, custodian and manager of the Central Valley Project, but the farmers and the communities which the project serves nowadays take little note of that fact. The people accept the great project as a part of their way of life. This may well be the ultimate accolade bestowed upon a bureaucrat; his work is so well done that his handiwork, in the thoughts of those whom it serves, becomes one with the mountains and the valley, the rain and the sun. They accept it and cannot do without it . . ."

Reference No. 3

This independent evaluation of "The Economic Impact of the Central Valley Project" lends strong support and substantiation to the "in-house" findings discussed in this report.

The Denver Research Institute (University of Denver) several years ago, explored methodologies for estimating the national economic impacts of Federal Reclamation programs. A method was ultimately devised which was considered credible but conservative. It developed what are considered accurate, quantitative, estimates of both direct and indirect impacts attributable to multipurpose water resource developments. The methodology was designed to identify and trace the direct and first-round indirect impacts and to categorize and summarize them into significant measures of economic activity.

This methodology, developed by Dr. J. Gordon Milliken and others, incorporates partial estimates for <u>some</u> of the major economic impacts of water resource developments. The various types of economic outputs are combined into six categories--water and power activity, agricultural water, municipal water, industrial water, hydroelectric power, and recreation (combined with fish and wildlife). Elements of project achievement such as water quality control, navigation, and flood control

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are not included in Dr. Milliken's analysis, thus lending credence to the assertion that the results of such analyses are conservative but nonetheless credible. Extracts from and references to Dr. Milliken's report have been treated in foregoing portions of this report. They provide supportive evidence to findings presented herein.

## TRAINING GROUND AND INTERNATIONAL SHOWCASE

Many major pioneering efforts in large-scale water resource developments had their inception and nurturing in the Central Valley Project. This highly developed, complex system of reservoirs, powerplants, canals, and other diverse, but interrelated project works of massive proportions is one of the largest and most widely acclaimed systems of water resource developments undertaken by the Bureau of Reclamation during its illustrious history.

It was this Project setting that served as a training ground for many of the great engineers and architects of the future who graduated from the "College of Central Valley Project Experience." It was here during the metamorphosis of the Central Valley Project undertaking, that many new planning, design, construction, and operational management concepts and practices were first tested. The importance of experience they gained here is acknowledged by many of the Nation's great water resource development professionals. Through Central Valley Project portals have passed renowned water resource development technicians and professionals from many nations of the world. Testimonials and commendations received from them attest to the major contributions which the Central Valley Project has made to the socio-economic well-being and quality of life in many diverse areas of the world. This training, perhaps, constitutes one of the more outstanding contributions of Central Valley Project, wherein it has proven to be a major "showcase" of international recognition.

## FUTURE NEEDS

The Central Valley Project provides a very important portion of the total water supply needs of California's great Central Valley basin. However, it is by no means the only supplier. Other developments by the State of California, the U.S. Army Corps of Engineers, and many water districts and individuals combine to makeup the total supply. The achievements are impressive, but much remains to be done to provide additional reliable supplies to offset continuing ground-water overdrafts and permit continued economic development and expansion of the area.

Many complex problems remain. They include such

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vexing matters as developing new supplies; improving management and control of ground water; resolving institutional and legal constraints; and improving conservation and efficiency in the use or reapportionment of presently developed supplies. All of these problems relate to issues of economics, equity, efficiency, administrative procedures, and political and environmental accommodations. They must be resolved in order for the great Central Valley to continue its economic development in the general public interest to the benefit of California and the Nation.